

A clinical validation of the MR-compatible Delta4 QA system in a 0.35 tesla MR-Linac

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62nd Annual Meeting of the American Association of Physicists in Medicine, Vancouver

Introduction

- As integrated linear accelerator and magnetic resonance imaging (MRI) system (MR-linacs) continue to increase in popularity, quality assurance (QA) tools that are MR-compatible also become necessary.
- In this work, the performance of an MR-compatible version of the Scandidos Delta4 Phantom+ (Scandidos, Madison, WI) was validated by measuring clinical plans on a 0.35T MR-Linac system.

Methods

- The MR-compatible Delta4 Phantom+ was calibrated on the 0.35T MR-Linac system using the procedure recommended by the manufacturer.
- A total of 39 clinical plans were used to assess the performance of the device. These plans spanned several anatomical treatment sites previously treated on 0.35T MR-linac including abdomen (15), lung (7), liver (9), and kidney (8).
- Patient-specific QA plans were generated by transferring clinical plans to the MR-compatible Delta4 Phantom+ geometry and recalculating them. The geometric center of the phantom was placed into regions of high dose and low gradient to ensure that the high dose target region was being sufficiently sampled by the physical measurement. The QA plans were then delivered to the MR-compatible Delta4 Phantom+ system.
- Dose differences at levels of 2% and 3% along with distance to agreement (DTA) values of 2 mm and 3 mm were recorded as well as 2%/2mm and 3%/3mm global gamma pass rates using a 20% maximum dose threshold. These results were then compared to previous patient-specific QA measurements conducted at our clinic using a Sun Nuclear ArcCHECK® (Sun Nuclear Corporation, Melbourne, FL) system.

Results

- Figure 1 compares average global gamma pass rates between the MR-compatible Delta4 Phantom+ and the ArcCHECK across each group based on anatomical site of treatment.
- Table 1 and Table 2 summarize the 3%/3mm and 2%/2mm gamma pass rates, respectively.
- Figures 2 and 3 compare each clinical plan's global gamma pass rate between the MR-compatible Delta4 Phantom+ and the ArcCHECK. Figure 2 compares the 3%/3mm results and Figure 3 compares the 2%/2mm results between both devices. The data are once again grouped based on the anatomical site of treatment.

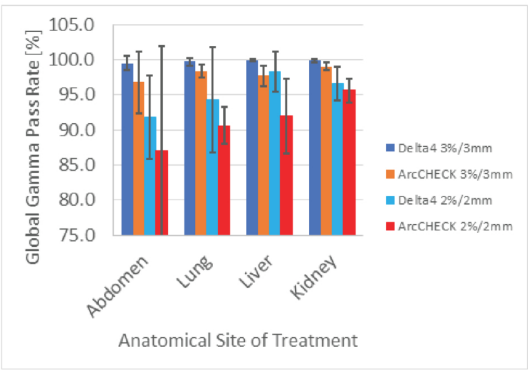


Figure 1: Comparison of average global gamma pass rates between the MR-compatible Delta4 Phantom+ and the ArcCHECK

3%/3mm Global Gamma Pass Rate						
Site	Delta4			ArcCHECK		
	Mean	Std	Min	Mean	Std	Min
Abdomen	99.5	1.0	96.4	96.8	4.4	83.9
Lung	99.7	0.6	98.6	98.4	0.9	97.3
Liver	99.9	0.2	99.5	97.7	1.5	95.0
Kidney	99.9	0.3	99.3	99.0	0.5	98.3

Table 1: Comparison of 3%/3mm global gamma pass rates between MR-compatible Delta4 Phantom+ and ArcCHECK

2%/2mm Global Gamma Pass Rate						
Site	Delta4			ArcCHECK		
	Mean	Std	Min	Mean	Std	Min
Abdomen	91.8	6.0	78.9	86.95	14.9	55.1
Lung	94.2	7.5	78.1	90.60	2.6	85.7
Liver	98.3	2.9	91.2	91.94	5.4	79.2
Kidney	96.6	2.4	93.4	95.59	1.7	92.7

Table 2: Comparison of 2%/2mm global gamma pass rates between MR-compatible Delta4 Phantom+ and ArcCHECK

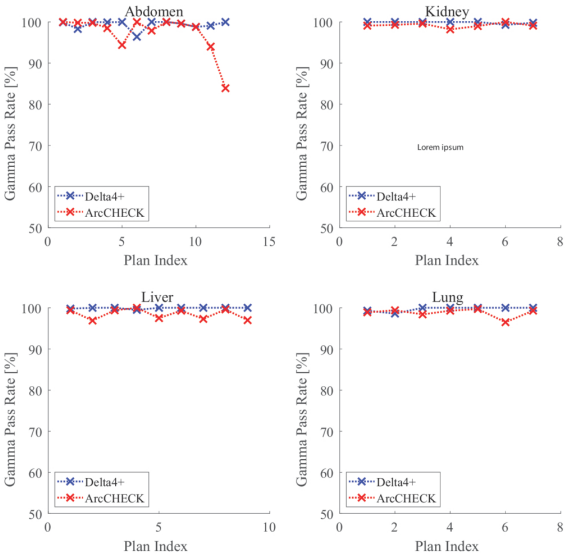


Figure 2: Comparison of each plan's 3%/3mm global gamma pass rate grouped by anatomical site of treatment

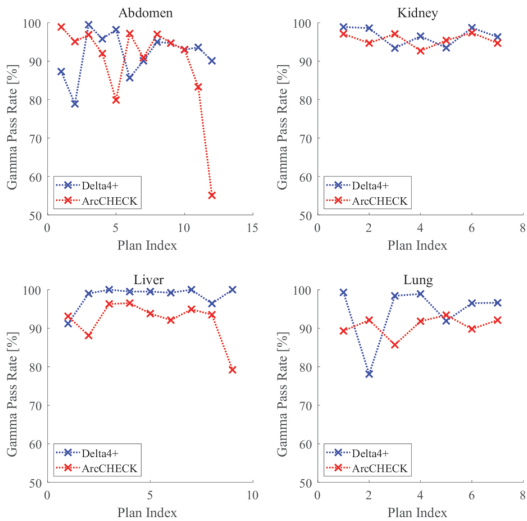


Figure 3: Comparison of each plan's 2%/2mm global gamma pass rate grouped by anatomical site of treatment

Conclusions

- In all instances, the MR-compatible Delta4 Phantom+ gamma pass rates compared favorably to the ArcCHECK and frequently involved gamma pass rates greater than the comparable ArcCHECK measurement. This was true even for highly modulated plans which historically entailed low gamma pass rates.
- Based on these results, the MR-compatible Delta4 Phantom+ was found to be a suitable QA device for a 0.35T MR-linac.

Acknowledgments

The authors would like to especially thank:

- Scandidos